Active Noise Control for Acoustic Sensors

Presented at

DARPA Air-Coupled Acoustic Microsensors Workshop
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Crystal City, VA

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Active Noise Control

- **Application Areas in Acoustics**
  - **Industrial Noise and Vibration Reduction**
  - **Acoustic Stealth**
  - ***Acoustic Sensor Interference Rejection (Presentation Emphasis)***
- **Acoustic Sensor Interference Rejection Applications**
  - **Unmanned Vehicle Acoustic Sensors**
    - ***Undersea Weapons***
    - ***Unmanned Ground Vehicles***
    - **Internetted Unmanned Ground Sensors**
  - **Surveillance Systems**
    - **Communications Intelligence**
  - **Speech Recognition**
  - **Biomedical Acoustic Sensors**
  - **Multistatic Active Sonar**

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Air Coupled Acoustic Microsensor Technology Applications

- **Wideband Self Noise Cancellation**
  - **Reduce broad band self-noise by > 15 dB while retaining low far-field signal distortion**
  - **Develop coherent wind noise reduction techniques**
    - **Improve wind noise reduction by at least 20 dB using new sensors and adaptive noise control technology when compared to passive foam windscreens**
  - **Improves surveillance detection and classification performance**

- **Acoustic Skin**
  - **Conformal acoustic surveillance array**
  - **Integrated MEMS sensors, electronics and VLSI analog controller**
  - **Unobtrusive, compact and low cost**

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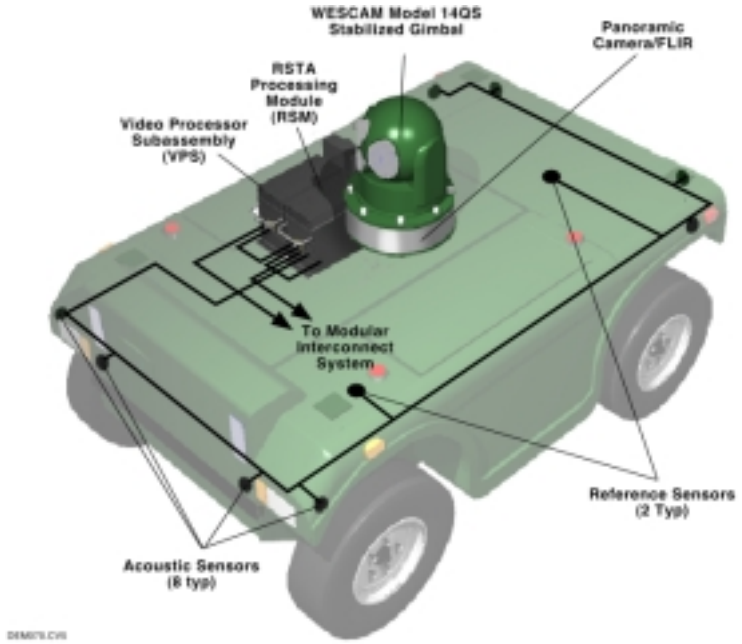
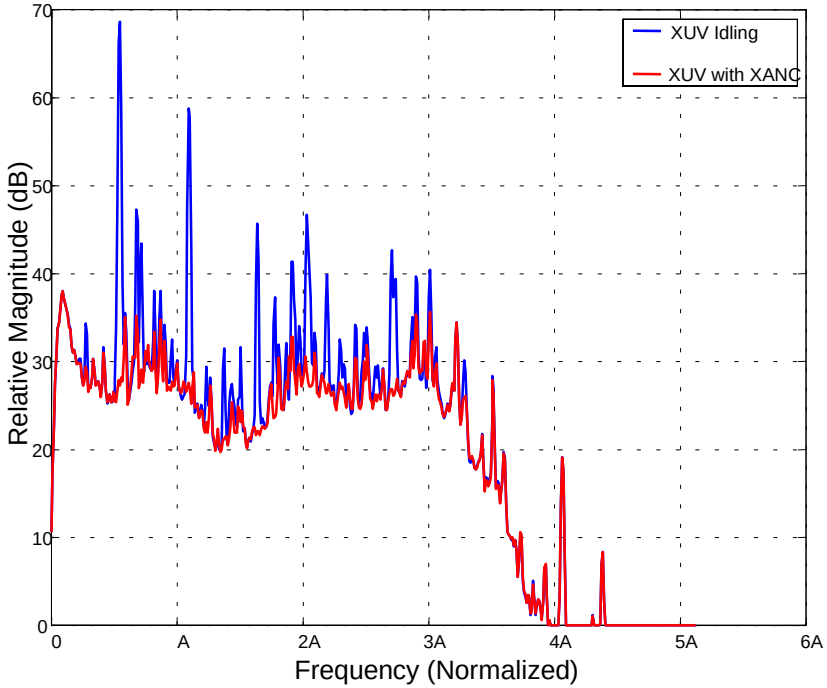
Self Noise Reduction for Acoustic Sensors

Demo III Experimental Unmanned Vehicle (XUV) Built By Robotic Systems Technology





Self noise reduction uses adaptive noise control techniques with microphone arrays and reference accelerometers

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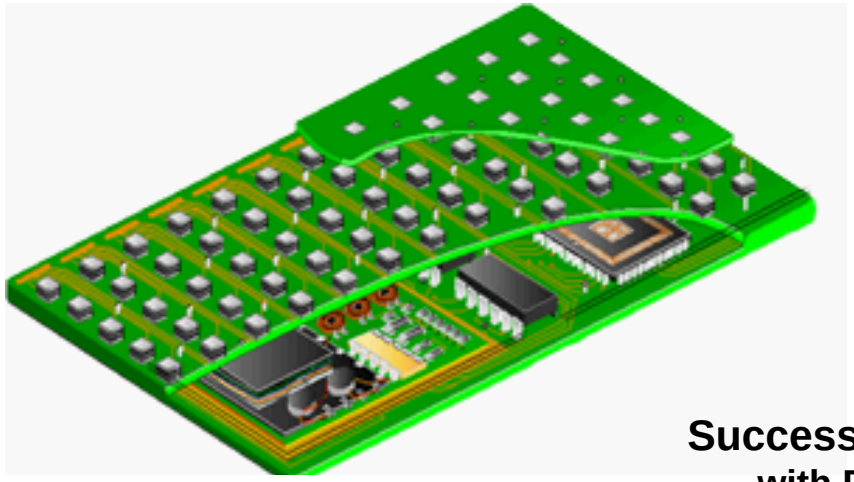
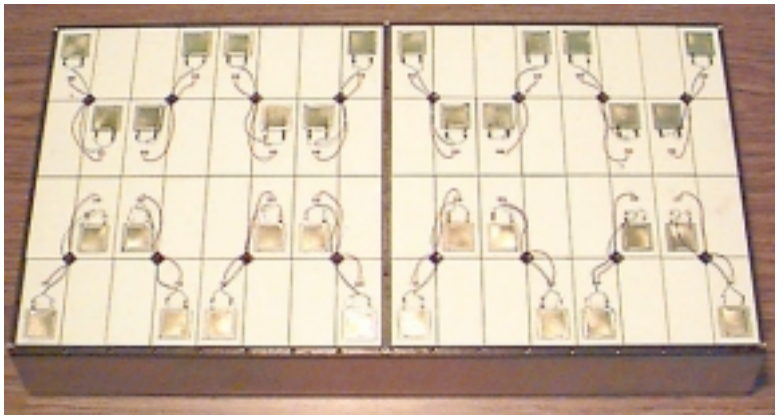
Composite Smart Materials (CSM)

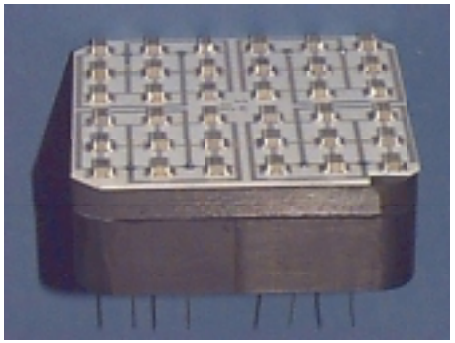




Successfully Demonstrated First Truly Smart Material
with Polyvinylidene fluoride (PVDF) pressure sensors
Micro-machined piezoelectric accelerometers
PMN Actuators
Embedded Electronics

DARPA/ONR Sponsored

Team Members
Lockheed Martin Advanced Technology Center
Active Signal Technologies
Naval Research Laboratory
Signal Systems Corporation
Virginia Power Technologies
Virginia Tech



3” Piston PMN Actuator with Integrated Sensor and Power Amplifier Electronics

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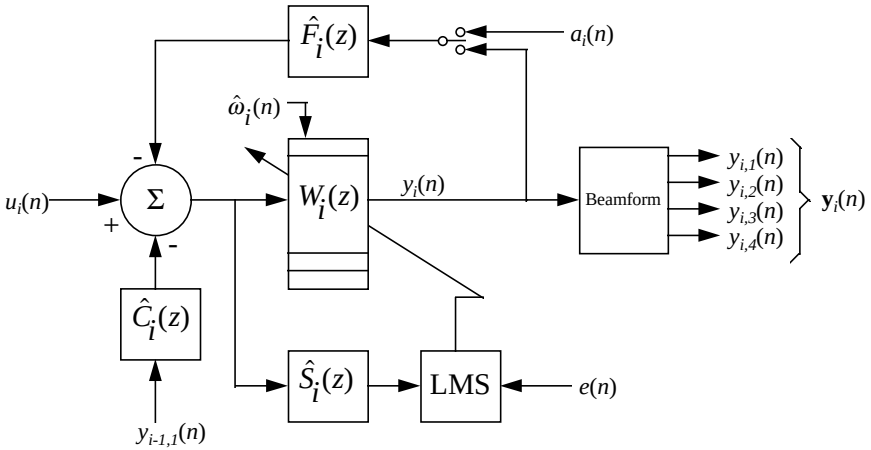
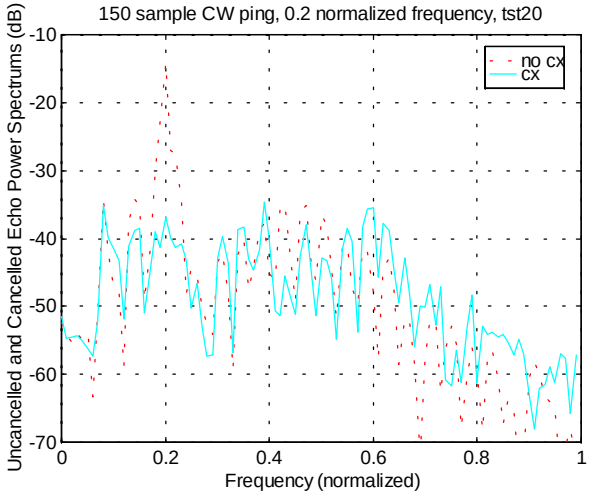
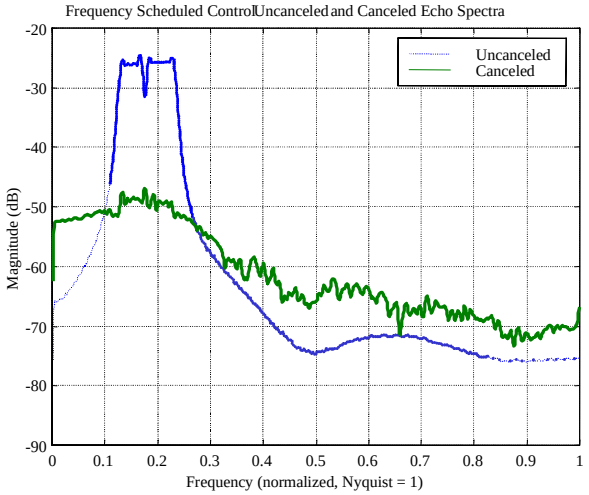
Smart Skins Control Technology for Echo Control



Hierarchical Control Systems Using Frequency Scheduled Control





Reference: L. Riddle and J. Murray, *'Smart Structure Active Sonar Echo Cancellation Using Frequency Scheduled Control*, Applications of Smart Structures Technologies, San Diego CA March 3-5, 1998.

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Smart Sleeve Self Noise Power Flow Isolation

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Active Signal Technology
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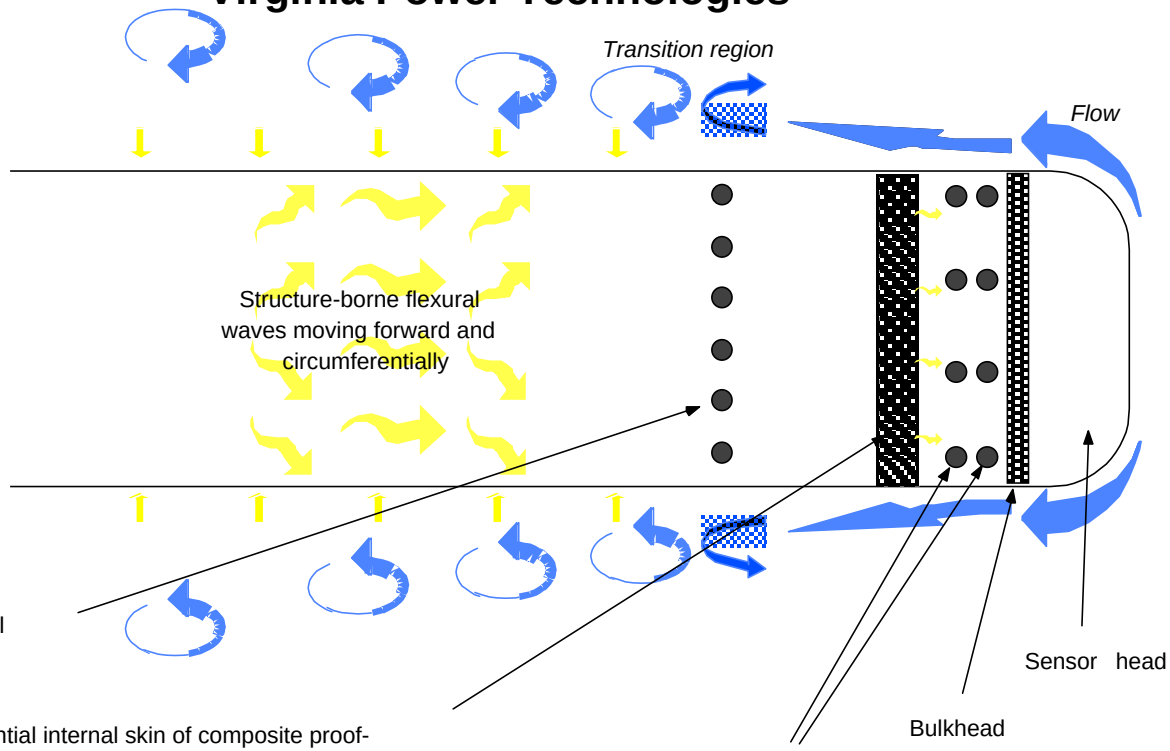
NUWC
Fuller Technology Inc.
Virginia Power Technologies



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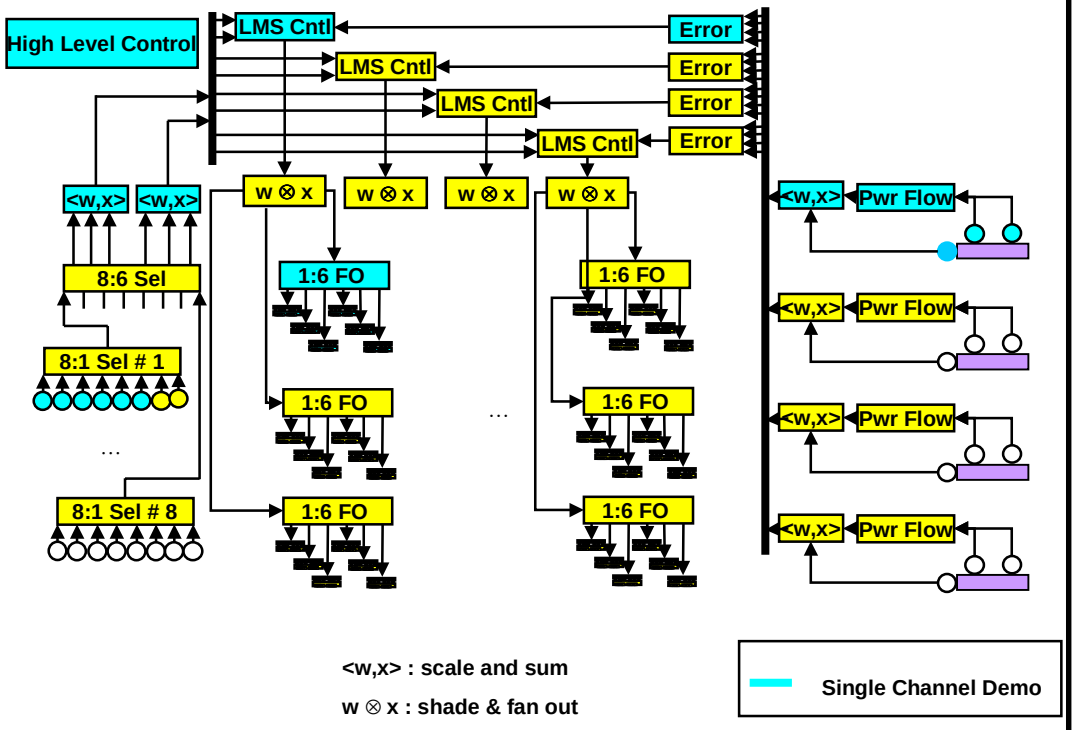
S2D Uses a Distributed Hierarchical Control System to Achieve Smart Material Control

- High speed /wide band central control
- Controller sample rate > 80 khz
- Fan-in/fan-out with gain to interconnect with large numbers of sensor and actuators
- Hardware built to fit as a skin, with distributed processing and no backplane
- Single channel demo is a partial build of the full control architecture
- Genetic algorithm reconfiguration of sensors



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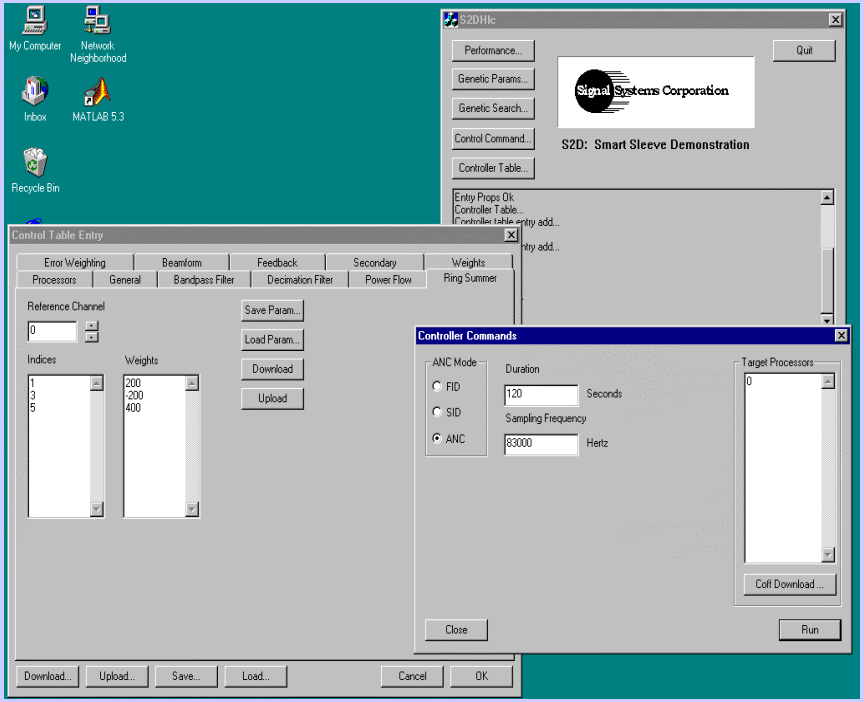
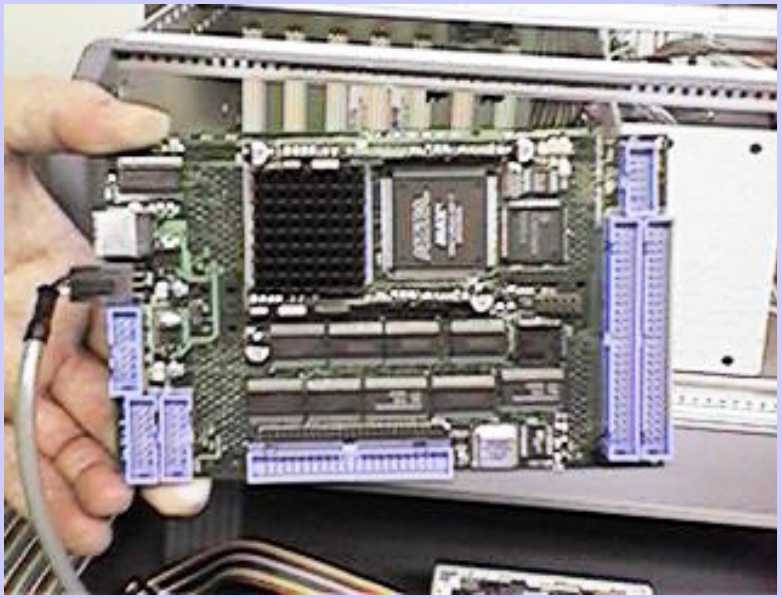
DSP Based Controller





Active Noise Controller SW
>80 kHz sample rate, 2 reference ch wavenumber error filters
Regulation BW: 3 kHz @ > 10 dB CX
Tunable band selection
In-situ system ID and optimization

Active Noise Control HW
16 Ch. I/O with anti-alias/anti-imposter filters, 16 bit ADC/DAC, TMS320C62 DSP @ 160 MHz
Compatible with Embedded Skin Applications

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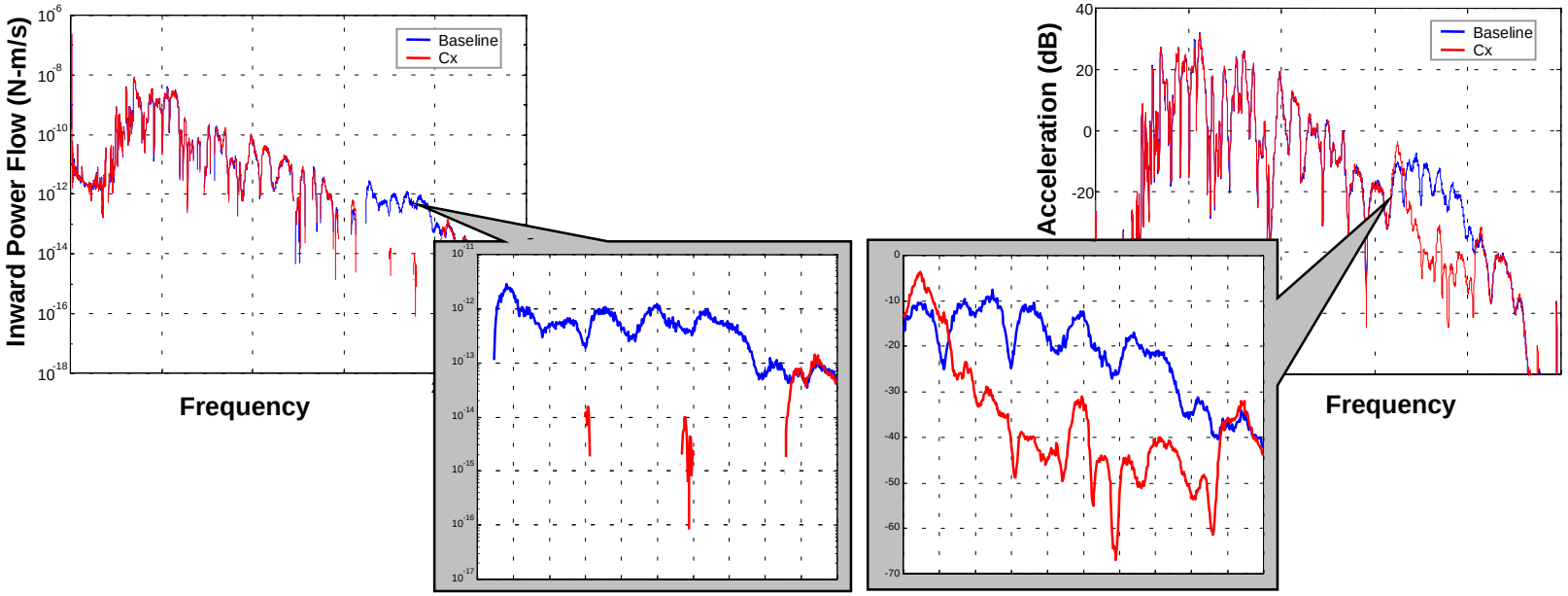
Smart Sleeve Single Channel Test Results
3 Khz Bandwidth Power Flow Control



Inward power flow measurement (Regions of net outward flow not plotted)

Real time controller error sensor spectra

Controller uses SW selectable bands to create frequency band windows in the TBL noise. Power flow measurement verifies proper control operation. 18 dB cancellation performance.

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